Vol. XL, No. 7
Concrete
July, 1932

# State Highway Design Standards *for* Paving One Traffic Lane

## Highway Traffic Service Supplied at Low Cost—Helps Counties Out of Mud—Present Practice in Illinois, Maryland, Delaware and Missouri

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SEVERAL state highway departments are utilizing single-track paving on portions of state and county highway systems. These states have found that the single track offers many advantages where traffic does not require a two-lane pavement or where it is desired to give all-year-'round road service on heavier traveled routes at a minimum of cost. There is no question that these latter roads should be paved for a width of two lanes; but, where highway funds are limited, experience has shown that the paving of one lane will give excellent road service. The single-track pavements can be constructed at about one-half the first cost of two-lane pavements. Maintenance costs are low, since traffic uses the single lane for the major part of the distance traveled.

In these same states, county highway departments are taking advantage of single-track construction and are using the state design standards. In counties the single-track idea has been used extensively, since funds are often limited while roads needing improvement may carry relatively high traffic volumes or a preponderance of heavy trucking. The use of the single paved lane permits rural communities to reach their markets and schools at any time and at the same time almost doubles the mileage of concrete paving which can be built with a given sum of money.

### Illinois Single-Track Standards

Illinois was one of the pioneers in the use of single-track paving. In 1913 a road law was enacted that established a state system of highways composed of a selected mileage of state-aid roads in each county. The state was obligated to help the counties build these state-aid routes on a fifty-fifty basis and also supply engineering advice. One of the first standards drawn up called for the paving of a single track, and this was recommended for county use at that time. As a result, a large part of the road construction in Illinois, from 1913 to 1918, when a state bond issue system of roads was established, was single-track paving. In 1918 a state bond issue system of roads was established and this activity of the state curtailed county road construction until 1929, when a 3-cent state gasoline tax gave the counties one cent for construction. However, these standards for single-track construction, first drawn up in 1913 and 1914, were still used by the progressive counties and on portions of the state bond issue roads.

The laws providing for the state bond issue routes permitted single-track construction wherever the highway officials thought it would serve traffic adequately. No

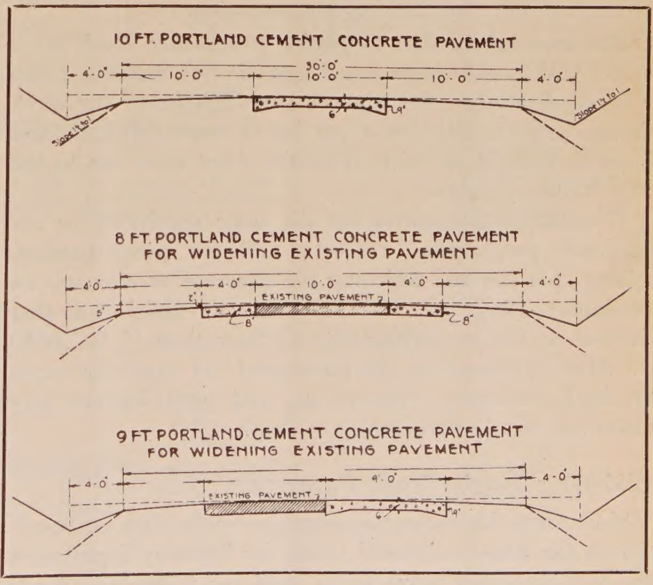
10 FT. PORTLAND CEMENT CONCRETE PAVEMENT
4'-0"
30'-0"
10'-0"
10'-0"
10'-0"
4'-0"
Slope 1½ to 1
Slope 1½ to 1
6"
9"
8 FT. PORTLAND CEMENT CONCRETE PAVEMENT
FOR WIDENING EXISTING PAVEMENT
4'-0"
4'-0"
10'-0"
4'-0"
4'-0"
2"
EXISTING PAVEMENT
5"
8"
8"
9 FT. PORTLAND CEMENT CONCRETE PAVEMENT
FOR WIDENING EXISTING PAVEMENT
4'-0"
9'-0"
4'-0"
EXISTING PAVEMENT
6"
9"

**Figure 1.** Recommendations of the Illinois highway department for single-track paving and widening

single track was used on the first 4,800 miles designated, since traffic was heavy and there were ample funds available for full width construction. The second bond issue designated an additional 5,000 miles of road, but did not supply enough money at first for full width construction. Accordingly, about 1928, the state construction program had progressed to the point where some routes having relatively light traffic were ready for construction and some single-track paving was built.

## Present Illinois Sections

The standards for single-track construction now recommended by the state for county use requires a 9-ft. or 10-ft. thickened edge design of 9-6-9 cross section, containing edge bars. No definite recommendations are made as to whether the single slab shall be located on the center line of the roadway or with one edge on the center line. Most counties use the off-center location, since it can be widened by construction on one side and only one shoulder requires maintenance.

When center line location is used the section is given a crown of ½ in. so that the pavement, when widened on each side, will have a crown of 1 in., the state standard. With one edge of the single track located on the center line of the roadway, the crown is obtained by dropping the outside edge 1 in. This serves the additional purpose of draining surface water to the unused shoulder and makes a marked difference in the maintenance needed at the pavement edge of the used shoulder.

The width of the single track is either 9 or 10 ft., the option resting with the county authorities. The state recommends the 10-ft. width, since this width makes it easier for the car passing onto the earth shoulder in wet weather to leave one set of wheels on the concrete. There is room for this to be accomplished on a 9-ft. width, but the additional foot of width is considered desirable by the highway department.

A roadway width of 30 ft. is used, and in case a 10-ft. slab is placed on the center line this provides two 10-ft. shoulders for passing. When the slab is located with one edge on the center line, 5-ft. shoulders for parking and 15-ft. shoulders for passing are available.

The roadway section is graded practically level for a center width of 20 ft. and each outside 5-ft. width is given a drop of 3 in. to the edge of the ditch line. The ditch design recommended in a cut has a depth of 2 ft. and is given a width of 4 ft. from the ditch flow line to the edge of the shoulder.

The state and counties use the same specifications for subgrade preparation, culverts, and for proportioning, mixing, placing and finishing the concrete as they use on two-lane construction. The pavements are finished so that there is no surface irregularity of more than ⅛ in. in 10 ft. After construction, the pavements are carefully cored to check thickness requirements, and penalties are provided for certain deficiencies in depth.

## Widening Single-Track Pavements

Since there has been considerable single-track construction in the state for several years, the highway department has also prepared plans to be used for widening. When widening an old single-track pavement which is on the roadway center line, a 4 or 5-ft. strip of concrete, depending on the width of the single track in place, is placed on each side of the old concrete, to a uniform thickness of 8 in. unless the old pavement in place has a 9-in. edge. In that case a uniform thickness of 9 in. is used. If the widening is all on one side, the present standard 9-6-9 section for single-track paving is used.

Special designs have been drawn up to cover cases where the old single track in place has an edge thinner than the central portion, commonly called thin-edge pavements. In these cases, the old pavement is underpinned for a distance of 1 ft. with an additional thickness of 6 in. of concrete. When the widening is on both sides, both edges of the old slab are underpinned in this manner; and the remainder of the widening, beginning at a point 12 in. from the edge of the old slab, is given a uniform thickness of 9 in. When widened on one side only, the side widened is underpinned and the extra thickness is extended into the new slab for a distance of 12 in. The remainder of the widening is the standard single-track thickened-edge design. In both cases of underpinning, the widening and underpinning are placed monolithic.

The use of single-track paving in Illinois is quite extensive on county work, and a total of more than 875 miles has been built to date. About 125 miles have been widened, practically all by the state when these roads were made part of the heavily traveled state bond issue routes. This leaves 750 miles still in use as single track, of which about 50 miles is on state routes that will be widened as money becomes available.

## Maryland Single-Track Standards

The Maryland state highway department standards for single track paving confine themselves to a description of the cross-section. When plans are drawn up for specific projects, the roadway width, ditch section, and so on, are drawn up to cover each particular case. As a rule, the off-center location is used and the details of construction practice conform to state standards. These sections are used on state routes that are built by the state as state-aid to counties. The Maryland laws provide for a certain amount of state construction in each county each year, and the use of single track permits the state to provide practically twice the mileage of road service that could be provided if two-lane construction were used.

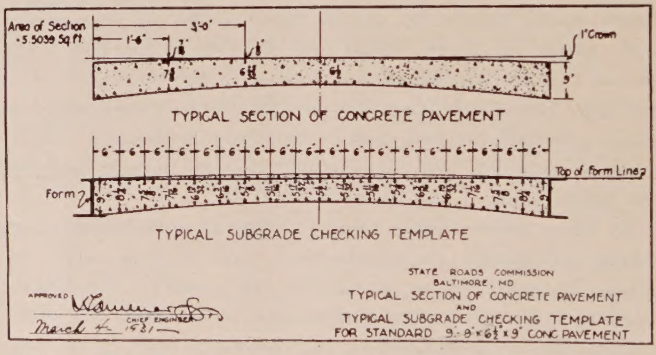
Area of Section
=5.5039 Sq. Ft.
3'-0"
1'-6"
1" Crown
9"
TYPICAL SECTION OF CONCRETE PAVEMENT
Top of Form Line
Form
TYPICAL SUBGRADE CHECKING TEMPLATE
STATE ROADS COMMISSION
BALTIMORE, MD
TYPICAL SECTION OF CONCRETE PAVEMENT
AND
TYPICAL SUBGRADE CHECKING TEMPLATE
FOR STANDARD 9'-9"×6½"×9" CONC PAVEMENT
APPROVED
CHIEF ENGINEER
March 4 1931

**Figure 2. Single-track pavement cross-section recommended by Maryland highway department**

The cross-section used in Maryland is a 9-6½-9 thickness with a 1-in. crown. The thickened edges are obtained by a gradual thickening from the center toward each edge, a slight variation from the standard Bates type section.

Single-track construction has been used in seven counties. The first single track was built in 1911 in Baltimore County, by H. G. Shirley, now commissioner of the Virginia State Highway Department, when he was county engineer. It is located at White Hall and extends from the paper mill to Gunpowder Falls. It is still in good condition, despite the fact that it received no maintenance for years. It has carried heavy loads from an adjacent stone quarry for the past five years, in addition to the hauling for the Pretty Boy dam.

The greatest mileage of single track has been built in Kent County, where more than 55 miles are in service. Kent County passed a bond issue for single-track construction in 1929 and completed about 50 miles in 1929 and 1930. The success of this movement to get the county out of the mud was attested to by Governor Albert Ritchie at the celebration held at the time the work was completed, when he said in part: ". . . Kent County stands out as an example for the whole state in farsighted and constructive enterprise." Total single-track concrete road

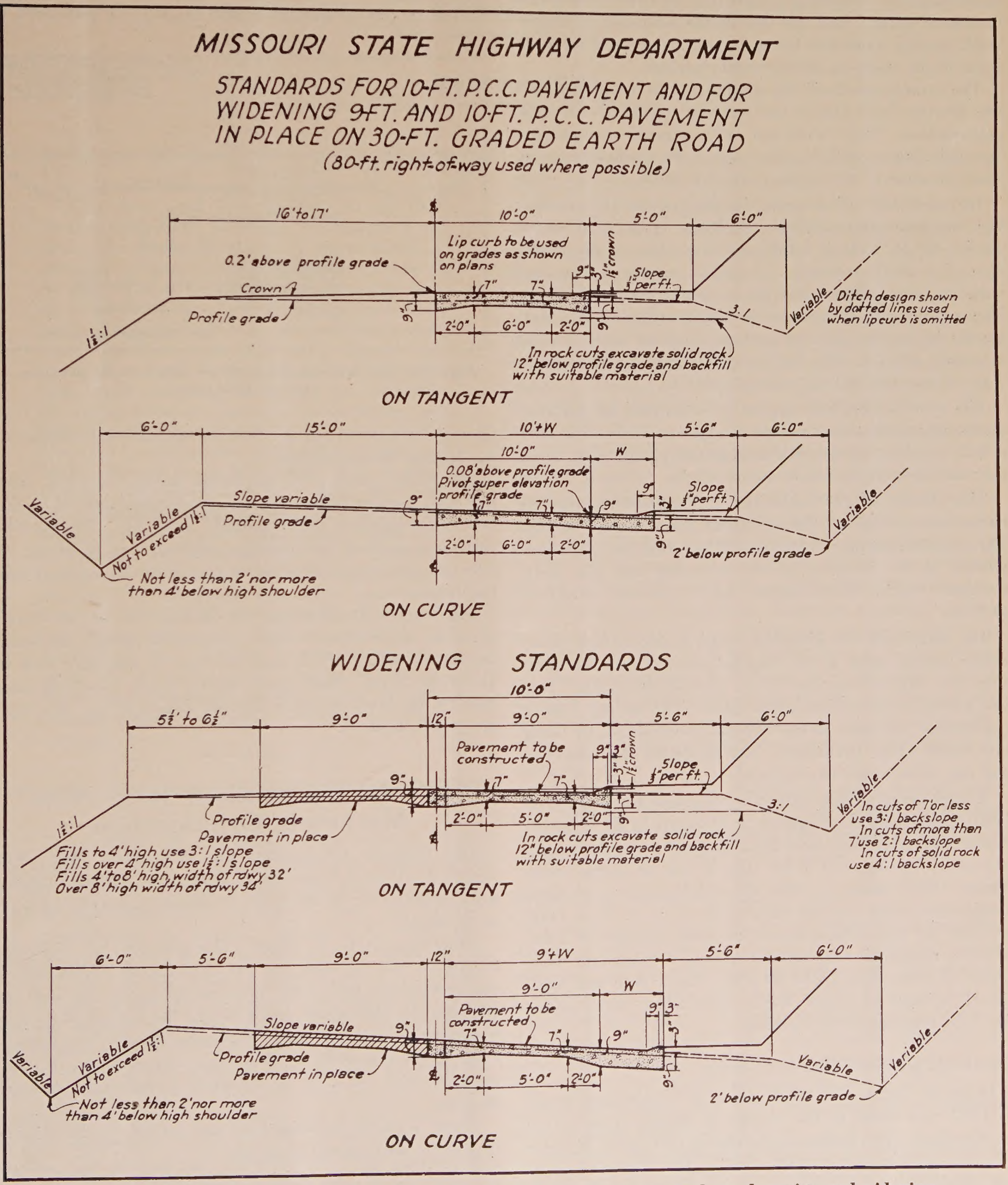
MISSOURI STATE HIGHWAY DEPARTMENT
STANDARDS FOR 10-FT. P.C.C. PAVEMENT AND FOR WIDENING 9-FT. AND 10-FT. P.C.C. PAVEMENT IN PLACE ON 30-FT. GRADED EARTH ROAD
(80-ft. right-of-way used where possible)
16' to 17'
10'-0"
5'-0"
6'-0"
Lip curb to be used on grades as shown on plans
0.2' above profile grade
Crown
Profile grade
1½:1
9"
7"
7"
9"
1½" crown
Slope ⅓" per ft.
3:1
Variable
Ditch design shown by dotted lines used when lip curb is omitted
2'-0"
6'-0"
2'-0"
In rock cuts excavate solid rock 12" below profile grade and backfill with suitable material
ON TANGENT
6'-0"
15'-0"
10'+W
5'-6"
6'-0"
10'-0"
W
0.08' above profile grade Pivot super elevation profile grade
Slope variable
Profile grade
Slope ⅓" per ft.
Variable
Variable
Not to exceed 1½:1
2'-0"
6'-0"
2'-0"
2' below profile grade
Not less than 2' nor more than 4' below high shoulder
ON CURVE
WIDENING STANDARDS
10'-0"
5½' to 6½"
9'-0"
12"
9'-0"
5'-6"
6'-0"
Pavement to be constructed
1½" crown
Slope ⅓" per ft.
Profile grade
Pavement in place
2'-0"
5'-0"
2'-0"
3:1
Variable
In cuts of 7' or less use 3:1 backslope
In cuts of more than 7' use 2:1 backslope
In cuts of solid rock use 4:1 backslope
In rock cuts excavate solid rock 12" below profile grade and backfill with suitable material
Fills to 4' high use 3:1 slope
Fills over 4' high use 1½:1 slope
Fills 4' to 8' high, width of rdwy 32'
Over 8' high width of rdwy 34'
ON TANGENT
6'-0"
5'-6"
9'-0"
12"
9'+W
5'-6"
6'-0"
9'-0"
W
Pavement to be constructed
Slope variable
Profile grade
Pavement in place
Variable
Not to exceed 1½:1
Variable
2'-0"
5'-0"
2'-0"
Variable
Variable
2' below profile grade
Not less than 2' nor more than 4' below high shoulder
ON CURVE

Figure 3. Standards of the Missouri State Highway Department for single-track paving and widening

construction in the state now equals about 100 miles.

### Missouri Single-Track Standards

The Missouri highway department built its first single-track concrete roads in 1924 as a result of their successful use in Mississippi County for the two preceding years. The Missouri state highway system is divided into two parts, known as the primary and secondary state systems. The secondary system carries less traffic than the primary system. Further, lack of funds made it necessary to devise some means of obtaining a high type of road service at a minimum outlay, and this led to the adoption of single-track paving standards for state and federal-aid work on some of the roads on the secondary system.

The present standards for single track in use in Missouri are derived from almost ten years of experience in their construction. They cover not only original construction, but widening as well, to take care of the further improvement of some of the single track first built.

In practically all respects the designs are the same as for two-lane construction. A Bates type 9-7-9 cross-section 10 ft. wide is built with one edge on the center line of a 30-ft. roadway. A $1\frac{1}{2}$-in. crown is specified with the center edge raised 2.4 in. above the profile grade line. A lip curb is used on the outside edge on all small grades in friable soils to prevent shoulder wash and to eliminate ditches. The lip curb is placed on the outside 9 in. of the slab and has a height of 3 in.

The shoulder designs require a 5-ft. width for parking on the pavement side, an earth road 11 or 12 ft. wide, and a 5-ft. shoulder on the half section not paved. The roadway section has a crown of about $2\frac{1}{2}$ in.

The standards for widening and super-elevation on curves are similar to the standards for two-lane paving. The super-elevation is obtained by pivoting the pavement section at the junction of the widening and the 10-ft. standard width. All widening has a uniform thickness of 9 in.

The standards for widening existing single-track pavements are the same as for original paving, with the addition of a strip of concrete 12 in. wide in the center. This has several construction advantages. The second lane is constructed the same as the original construction by using this center 12 in. for forms. The forms are then removed and the center concrete is placed.

A total of more than 530 miles of single track has been built on the secondary system in Missouri in 32 counties. About 120 miles have since been widened as funds became available, leaving 410 miles still in use as single track. Traffic counts taken in 1928 showed that many of these single-track roads carried an average of more than 1,000 vehicles per day, with a maximum daily average of 1,643 vehicles recorded. One section carried a maximum daily traffic of more than 2,800 vehicles. Each year sees additional mileage of single track constructed, with awards for 1931 totaling about 70 miles.

### Delaware Single-Track Standards

Delaware began the construction of single-track roads in 1927 as a result of the success of similar construction in Maryland. The Delaware standards call for a $7\frac{1}{2}$-$6\frac{1}{2}$-$7\frac{1}{2}$ cross-section and a width of 9 ft. The thickened edges are obtained by gradually increasing the pavement thickness from the center to the edges, as in Maryland.

The state uses off-center location. The center edge is placed at grade and the outside edge is dropped $1\frac{1}{2}$ in. to provide pavement crown and drainage. This drains the pavement surface water toward the unused sodded shoulder and eliminates considerable maintenance cost on the used shoulder.

A roadway width of 26 ft. is recommended, since all single-track construction is on the lesser used roads. This illustrates the savings in construction costs made possible by reducing the width of roadway. The roadway section is given a fall of 4 in. from the single-track pavement to the edge of each shoulder. A ditch section very similar to the Illinois design is used.

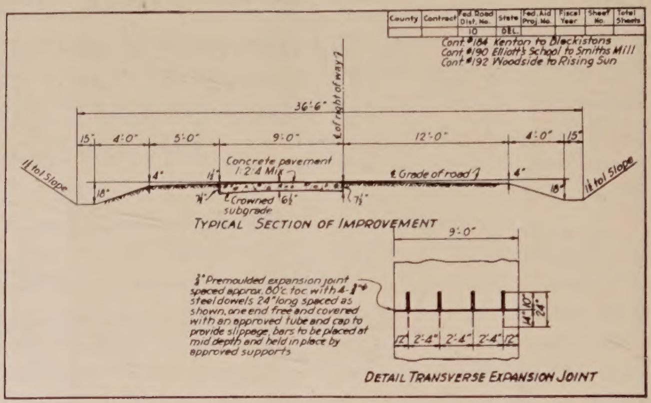
County
Contract
Fed. Road Dist. No. 10
State DEL.
Fed. Aid Proj. No.
Fiscal Year
Sheet No.
Total Sheets
Cont. #184 Kenton to Blackistons
Cont. #190 Elliott's School to Smiths Mill
Cont. #192 Woodside to Rising Sun
36'-6"
℄ of right of way
15" 4'-0" 5'-0" 9'-0" 12'-0" 4'-0" 15"
1½ to 1 Slope
Concrete pavement 1:2:4 Mix
℄ Grade of road
4"
1½"
18"
Crowned subgrade
6½"
7½"
TYPICAL SECTION OF IMPROVEMENT
9'-0"
¾" Premoulded expansion joint spaced approx. 80' c. to c. with 4-¾" steel dowels 24" long spaced as shown, one end free and covered with an approved tube and cap to provide slippage, bars to be placed at mid depth and held in place by approved supports
12" 2'-4" 2'-4" 2'-4" 12"
14" 10" 24"
DETAIL TRANSVERSE EXPANSION JOINT

**Figure 4. Typical section used on single-track construction in Delaware**

All other features of pavement design conform with the state standards for two-lane pavement, such as ¾-in. doweled expansion joints at 80-ft. intervals. The specifications governing the mixing, placing and finishing of concrete conform to these same specifications for two-lane construction.

Single-track construction is used in all of the three counties of Delaware. Each county has about the same mileage of single track, and the total in the state now is about 90 miles. Additional contracts are awarded each year by the state as funds become available for this type of construction.

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## Cincrete Corporation Joins New Marketing Organization

The Cincrete Corporation of Milwaukee, Wis., has joined the United Materials Corporation, formed recently with stabilization of the local building materials industry as its object.

According to L. E. Pitner, vice-president of Cincrete, the plant will be used for the manufacture of standard concrete block and other concrete products, as well as cincrete. In Milwaukee and Chicago the United Materials Corporation will sell these products directly to contractors. In the remainder of Wisconsin and northern Illinois, products will be sold to established building material dealers.

About a dozen organizations had joined by the middle of June or had agreed to do so.

Capital of the corporation is $1,050,000. Philip W. Grossman is president.

# Co-ordination of Basic Principles of Concrete Mixtures

## Controlled Production of Concrete a Manufacturing Process —Summary of Qualities Required of Concrete, and Elements Affecting Quality

### *III—Making Concrete for Modern Needs Is a Technological Manufacturing Process*

By JOSEPH A. KITTS
Consulting Concrete Technologist, San Francisco, Calif.

***The first and second articles of this series, under the subhead "Absolute Volume, the Basic Measure of Ingredients," introduced the modern thought expressed by this title as the most fundamental law of concrete mixtures. It was shown that lack of appreciation of this absolute volume fundamental—the use down the ages, of an indefinite measure of ingredients, bulk volume, including the variable air space between particles—accounts for the fact that today one of the most troublesome construction problems is how to make good concrete; that the fundamental principles of mixtures are not fully established and generally accepted matters of technical knowledge; that the fragments of fundamental principles of mixtures discovered by the individual workers in concrete research have not been co-ordinated heretofore; that current knowledge of concrete making is inadequate for modern requirements because the fundamental facts of mixtures have been obscured by the error of this ancient bulk volume measure.—The Author.***

As a corollary of the approximate measure of ingredients, there could be no exact technological process of concrete manufacture; the specified proportions of ingredients have necessarily been approximate and, accordingly, the greater volume of concrete produced today is specified in various arbitrary ratios, 1:1:2, 1:2:4, 1:3:6, 1:3, 1:6, 1:9, by loose-moist or dry-rodded bulk volume, or by weight, before the ingredients to be used are decided upon. A more modern procedure has been to send a few cubic feet of the materials to a laboratory for chemical and physical analysis, and the determination (by the Thacher, Fuller or other theory) of proportions for a satisfactory grading and quality; and then assuming subsequent uniformity of the materials as per samples. The most recent procedure of wide application has been to maintain the water-cement ratio in accordance with the Abrams water cement ratio strength law. None of these procedures has been complete as a technological process of concrete-making adequate for modern needs.

The most nearly complete technological process of concrete-making generally known is that of the Portland Cement Association, based on the Abrams dry-rodded volume measure, water-cement ratio and fineness modulus as presented by Abrams in "Design of Concrete Mixtures," first published in the minutes of the annual meeting of the Portland Cement Association, December, 1918, and elaborated in "Design and Control of Concrete Mixtures," published by the association, January, 1927. This work is the result of many thousands of experiments and research tests by the association subsequent to September, 1914. While this development of the water-cement ratio and fineness modulus principles has been the most important accomplishment in concrete mixture research, it has met an impasse due to its lack of appreciation of the absolute volume as the basic measure of ingredients. Until divorced from the dry-rodded bulk volume basis of measure of aggregates, it will have many limitations. However, a quarter million or more experiments by the association have supplied a great fund of data which has paved the way to the discovery and co-ordination of laws of proportioning, complementary to the water-cement-strength law; and a complete, simplified and expedient technological process of concrete-making is now available for the first time in the history of concrete.

Before going into the details of principles and their co-ordination, it should be appreciated that the making of strong and durable concrete, with economy, for modern requirements, is a technological process.

## Production a Manufacturing Process

Consideration of the general requirements of concrete, the complex elements affecting quality, the many special purposes and the economics of quality and efficiency in production, will show that the production of concrete of quality with economy is a complex manufacturing process demanding technological skill and special facilities of plant and laboratory. These considerations also show that there is no simple formula for the production of concrete of quality, any more than there is for cement, steel, or other structural products.

"Concrete" embraces the product of various mixtures of rock particle aggregates, hydraulic cements, fresh water, and admixtures, in innumerable possible combinations, which, after being placed in the mold or forms in a plastic or fluid state, harden under water or in air into artificial stone. The resulting concretes have as many different physical characteristics (workability, flowability and cohesion in the fresh mix, and strength, density, etc., in the cured concrete) as there are combinations. Concretes of definite qualities are made only by definite technological processes, and the general problem of making good concretes, for many purposes, of many types of materials, and with fundamental economy, is a comprehensive and complex one in the many conditions to be evaluated. We may have any maximum size of aggregate up to 12 in. in diameter, any proportion of cement, a wide range of water content, any degree of consistency or flowability from dry and stiff to wet and sloppy, and any strength up to 10,000 or even 20,000 lb. per sq. in. at a given age.

Concretes of definite qualities, in consistency of the fresh mix, strength, density, impermeability, texture, must have definite structures of mix in definite absolute volumes of the cement and water and of aggregates of various diameters, and these qualities and basic mix structures must be predetermined by tests with the given types of aggregates and cements as the materials vary from day to day.

A specific concrete is described by three general requirements: (1) Maximum Size of Aggregate; (2) Workability (slump or flow); and (3) Compressive Strength at a given age.

### Many Characters of Cements

Concretes are made with many kinds of hydraulic cements. While the principles of mixtures are the same for all hydraulic cements, the resulting physical values of the concretes are widely different for the same cement contents.

### Types of Aggregates Innumerable

Artificially prepared aggregates are crushed brick, blast-furnace slag, coal cinders, crushed and burned shale, and various other materials. The natural aggregates may be igneous, sedimentary or metamorphic rocks and, in the case of gravel, the natural deposit may be various combinations of these three general classes of rocks. The number of size separations of aggregates used to make a particular mixture may be one or more; two to four sizes are generally used and, for 12-in. maximum size, from eight to twelve sizes may be used to advantage. Aggregates from a given source and plant vary from day to day in fineness, specific gravity, density, moisture content and absorption. Measured proportions for concrete today give poor results tomorrow, because of these changes.

With a given cement content and water-cement ratio, the strength, density, impermeability, durability and workability of the resulting concretes vary widely with the shape, grading, maximum size and the peculiar physical and chemical characteristics of the various classes of rocks.

### Many Admixtures

Admixtures of various earths, minerals, chemicals, oils and emulsions, are used in concrete to increase workability, flowability and cohesion, to accelerate or retard setting, as waterproofing, as hardeners, or as cure-alls. Some admixtures have merit in one or more respects.

### Many Qualities Required of Concrete

The essential characteristics of concrete, determining the technological processes, are as enumerated in the following, the relative importance of each depending upon the use:

1. Durability: Concrete must be composed of such ingredients and in such definite proportions that it will have, with due regard to the conditions of use, resistance to ice, fire, salts, liquids, gases, wear, stress.

2. Impermeability: The essential quality of concrete for marine and hydraulic structures is impermeability to fluids. Impermeability is important in the protection of steel reinforcing.

3. Strength: Structural concrete must have elastic resistance to flexural and compressive stresses of various definite, predetermined amounts per square inch. Resistance to wear is largely dependent upon the strength.

4. Density: Concrete of the maximum workable density of solids has the optimum of weight, strength, impermeability and durability in proportion to cost.

5. Uniformity: Uniformity of quality can be obtained only by uniformity of mix structure. Uniformity of texture is essential in architectural concrete.

6. Workability, Flowability and Cohesion in the Fresh Mix: Concrete must have a workability, flowability and cohesion in the fresh mix suitable for the conditions of use. This means adequate cement and water and a proper uniformity and fineness (or coarseness) of grading of the mixed aggregate.

7. Economy: Economical concrete is that which has values in strength, durability, and other properties, adequate for the purpose and sufficient to make a proper return on the investment. Saving of cement by the making of mixtures too dry for the conditions of use and necessitating an excessive expenditure of labor in placing and patching, is not economy. On the other hand, extravagant and inefficient use of cement, which permits of no return on the investment, is not economy, and the money so expended never buys another yard of concrete, barrel of cement or day of labor. Comparison of results will show that economical concrete is obtained by employment of efficient materials, efficient production equipment, skilled workmanship and technological skill in control of production. Concrete, of a given strength, made without technological manufacturing skill, requires additional cement and costs from $0.15 to $3.00 more per cubic yard, the additional cost increasing with the strength and workability required. Normal standard portland cement concrete having the greatest strength in proportion to its cost is that having a strength between 3,000 and 4,000 lb. per sq. in.; and, using that strength as a basis of structural design, savings of $0.03 to $0.25 per total square footage of floor area are effected as compared with usual designs for 2,000-lb. concrete.

The evidence is quite clear that fundamental economy in the use of concrete lies in improvement in quality by improvement in manufacturing processes. Just as portland cement itself has been made more economical and improved in quality by better technological facilities of manufacture, so is concrete being made more economical.

### Elements Affecting Quality

The accomplishment of these requirements depends upon evaluation of the following elements affecting qualities and characteristics of the concretes:

Cement quality and content, chemical and physical characteristics;

Water to cement ratio;

Lithologic quality, shape, maximum, minimum and average sizes of aggregate particles, specific gravity, moisture content and absorption;

Uniformity and character of grading of the mixed aggregate;

Cement to voids in the fine and in the mixed aggregate;

Sand and mortar to voids in the coarse aggregate;

Accuracy of the absolute volume measure of aggregates, cement and water;

Time and efficiency of mixing;

Consistency, workability, flowability and cohesion of mix;

Workmanship in measurement, mixing, placing and curing;

Moisture and temperature of curing; and

Practical and technical manufacturing control on the job as required by the foregoing variables.

### Preliminary, Control and Research Tests Essential

Given any set of materials and a project requiring concretes for various purposes, preliminary studies must be made of basic mixtures of the material before satisfactory mixtures can be determined. Basic mixtures so determined must be sustained during production by constant testing of the materials and readjustments of the measured proportions as the physical characteristics of the materials vary. Special materials and special requirements necessitate special research tests and studies. The ever-changing conditions and demands require constant research as a normal operation of concrete production.

### Scope of Concrete Research

Considering the whole gamut of practicable mixtures, it is readily seen why there is no simple, absolute formula of mixtures such as 1:2:4, water-cement ratio, and so on. With a given kind and maximum size of aggregate, a given cement, and a given slump or flow of mix, there is an equation for the cement content for any strength, related to an equation of the water content, related to an equation of the fineness modulus of grading, related to a formula of grading, related to an equation of the yield of combinations.

Appreciation of the enormous task which has confronted concrete research in the past, in the determination of the laws of mixtures, supplies convincing proof of the technological character of concrete making, shows the involved and abstruse difficulties of the exploration, and accounts for the groping progress. In order to determine the effect of change of cement content, for example, all other effects must be held constant. Likewise, this is true in the determination of the effect of maximum size of aggregate, of fineness modulus, of consistency. In order to determine the mathematical curve of cause and effect we must have at least four values of cause and four corresponding values of effect. Taking the simple case of a given type of cement and aggregate, determinations of the effects of maximum size of aggregate, fineness modulus, cement content and consistency, require mixtures with four different maximum sizes of aggregates, four different gradings of each, four different cement contents of each, and four different consistencies, a total of 256 mix combinations. This may be multiplied in turn by the number of types of aggregates, the number of types of cement, of admixtures, or of mixing time, which may make a total of 20,000 or of 50,000 mixtures. Determinations of yield, weight, strength, density, equations of cement content, fineness modulus, water content, and so on, may amount to 500,000 determinations.

Knowing the laws for practical limits of the cement content, of the water content, of the fineness modulus, of the maximum size, and of the yield of combinations, 16 concrete mix combinations and 4 neat cement-water mortars are required instead of the 256 mentioned previously.

### Commercial Central Plant Production

The industry of making concrete at central plants is, on the face of it, a manufacturing industry. The daily problem of technological control is to produce concrete of a number of different maximum sizes of aggregates, of a number of definite strengths, of a number of definite consistencies, and of correct yield. The tolerance for error or measurement in strength tests varies; slump must be within ½ in. (plus or minus), and the yield must be within one-half of one per cent with the first load delivered. In consequence, trial batch methods are impractical and inadequate.

Appreciation of this evidence that the making of concrete for modern needs is a technological manufacturing process will encourage research and do much to improve the cement and concrete production industries. Such an appreciation will bring forcibly to mind the necessity for co-ordination of the fragmentary knowledge of fundamental principles of mixtures.

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## Corrected Values in Design Table

It is to be regretted that the article by Frank A. Hill, on "Bending Stress in Concrete Columns," printed on pages 31 and 32 of the June issue, contains incorrect figures which were supplied for several of the values in Table 1.

In the fifth column of the table itself (under 0.4), the value 0.2377 should be 0.2365, and the second value below that should be changed from 0.2389 to 0.2377.

In the notes at the right of the table, in the second to fifth lines, change 0.0346 to 0.1607; change 0.1065 to 0.1837; change 0.0281 to 0.1333; and change 0.9787 to 0.1733.

## Index Note

Volume 40 of CONCRETE will continue to run through the balance of the year instead of concluding with the June issue.

An editorial index of issues from January, 1932, to December, 1932, inclusive, will be published at the close of the year.

# Specifying Color and Finish of Architectural Cast Stone

## *Proposed Commercial Standard Provides Method of Comparison with Samples—Suggested Working Specifications Are Also Offered as Guide*

THE Cast Stone Institute has submitted to the U. S. Department of Commerce a proposed commercial standard covering colors and finishes for cast stone, a preliminary meeting of interested manufacturers having been held in Washington on June 17, 1932.

### Specifying Appearance

As usually written, specifications covering the appearance of cast stone are subject to widely different interpretations by different manufacturers, which leads to confusion and misunderstanding. While such attributes as strength, density and absorption can be definitely specified and easily measured by tests, appearance is an intangible thing that can not be described in writing so as to have but one interpretation. The responsible manufacturer needs specifications that are complete and clear, so that he will know exactly what is wanted and what other manufacturers will bid on. This completeness and clearness can be realized only by requiring the appearance —the color and finish—to be in agreement with a standard sample.

### Exact Duplication Not Expected

Since aggregate is the principal ingredient of cast stone the appearance, and to a less extent the quality, of the finished product is largely dependent upon the aggregate used in its production. For exact duplication of a sample, the same aggregate or one having identical characteristics would be required. However, for all practical purposes an absolute match is not necessary and the method for comparing samples is prescribed with this in mind.

It is not expected and not intended that cast stone manufacturers in different sections of the country shall use aggregate, or even cement, from the same source in producing cast stone to match the various standard samples. It is expected and has previously been demonstrated that raw materials of sufficient similarity for the production of cast stone matching a given sample are generally available to manufacturers throughout the country. Standard samples of cast stone therefore in no wise restrict competition among manufacturers, but instead tend to broaden and equalize competition. Of equal importance, standard samples will provide a means by which purchasers of cast stone can specify exactly what is desired and a standard by which the delivered product can be judged.

### Method of Making Comparisons

In making comparisons with standard samples, observations shall be made from a distance of ten feet. The surfaces being compared shall be in a vertical plane or preferably shall be tilted backward at an angle of 30 deg. from the vertical. Comparisons shall be made under daylight, preferably the light from a northern sky. If desired, the two surfaces to be compared may be covered by a mask of gray paper, cardboard or cloth of such size and with such rectangular opening in the center as to give maximum exposure and provide a neutral colored area around the two surfaces. The surfaces being compared shall be considered to match satisfactorily if there is no distinguishable difference in their appearance under the specified conditions of comparison.

### Recommended Specifications

The following working specifications are not to be considered a part of the proposed commercial standard submitted by the Cast Stone Institute, but are offered as a guide in the preparation of complete working specifications for each job. Additional requirements on architectural details usually will be necessary. The suggested specifications cover—

(a) Cast Stone purchased under Federal specification No. SS-S-721.

(b) Cast stone purchased under private specifications.

(Beginning of Specifications)

### Cast Stone Purchased Under Federal Specifications

Quality, Type, Finish, Workmanship, etc.—Material indicated on drawings as cast stone shall be cast stone of Type No. —— as classified by Federal Specification SS-S-721 and shall meet all applicable requirements and tests of that specification. It shall closely match in color, finish and texture Standard Sample No. ——. All pieces shall be true to dimensions and profiles with sharp, straight edges. Moldings and arrises shall be sharp, true and continuous at the joints. All ornamentation shall faithfully reproduce models or details and unless otherwise specified shall be treated to show a texture and appearance similar to the rest of the work.

Cast stone shall be thoroughly cured and seasoned and shall have attained the specified strength and density before being delivered to the building site. No cast stone shall be delivered before it is 21 days old.

### Cast Stone Purchased Under Private Specifications

Quality, Type, Finish, Workmanship, etc.—Material indicated on drawings as cast stone shall be the product of an established plant having capacity and facilities for producing the specified quality and quantity of cast stone without delaying the progress of the work. Cast stone shall have a compressive strength of not less than 5,000 lb. per sq. in. and an absorption not greater than 7 per cent when tested according to the requirements of American Concrete Institute Tentative Specification P-3-A-29T or Federal Specification SS-S-721.

Cast stone shall closely match in color, finish and texture Standard Sample No. ——. All pieces shall be true to dimensions and profiles with sharp, straight edges. Moldings and arrises shall be sharp, true and continuous at the joints. All ornamentation shall faithfully reproduce models or details and unless otherwise specified shall be treated to show a texture and appearance similar to the rest of the work.

Cast stone shall be thoroughly cured and seasoned and shall have attained the specified strength and density before being delivered to the building site. No cast stone shall be delivered before it is 21 days old.

# Research in Concrete Shows Results in Sessions of A. S. T. M.

THE thirty-fifth annual meeting of the American Society for Testing Materials, held at Atlantic City, N. J., from June 20 to 24, devoted the morning and afternoon sessions of June 24 largely to the cement and concrete industries.

## Concrete and Concrete Aggregates

Cloyd M. Chapman,[1] chairman of Committee C-9 on Concrete and Concrete Aggregates, submitted revisions of the standard methods for the determination of organic impurities in aggregates, for determining the sieve analysis of aggregates, and for making and testing compression test specimens. Other revisions were suggested in connection with the tentative method for determining the soundness of aggregates and in the test for structural strength of fine aggregates. A suggested method for conducting freezing and thawing tests was presented.

Other subjects now being studied by Committee C-9 include ready-mixed concrete and light-weight aggregates.

## Volume Changes in Early-Strength Concrete

E. R. Dawley[2] presented a paper on "Volume Changes of an Early-Strength Concrete," in which he compared results obtained with the use of an early-strength cement and an ordinary portland cement.

Among other comparisons, it was found that the relation between the water-cement ratio and the strength is of a different character with early-strength cement than with ordinary cement.

The coefficient of thermal expansion proved to be more affected by the kind of coarse aggregate used than by the kind or amount of cement.

The coefficient of moisture expansion increased with increased cement content. Wet mixes (7-in. slump) absorbed more water than dry ones (2-in. slump).

Freezing-and-thawing tests indicated that specimens made with the early-strength cement were more durable than those made with ordinary portland cement.

## Consistency and Strength of Concrete

Tests made at the Fritz Engineering Laboratory of Lehigh University during the winter of 1931-1932 were reported by Inge Lyse.[3]

The tests indicated that the consistency of concrete remains constant regardless of the richness of the mix so long as the type and gradation of the aggregates and the water content per unit of fresh concrete remain constant. Two series of tests were made. One series indicated that different brands of cement had but a slight effect on the consistency of the concrete, while the richness of the mixture had practically no effect. The other series showed that the type and gradation of aggregates had a decided effect upon the water requirement for a given consistency of the concrete.

## Concrete Drain Tile

Anson Marston,[4] chairman of Committee C-6 on Drain Tile, reported progress in several of the research projects sponsored by that committee.

The study of the durability of concrete drain tile in alkali and peat soils, by the Bureau of Agricultural Engineering in co-operation with the University of Minnesota and the Minnesota Department of Drainage and Waters, has been practically completed for alkali soils. All of the data are being prepared for publication in bulletin form.

During the summer of 1931 the Portland Cement Association made the 10-year examination of the field specimens in their study of the durability of concrete in alkaline soils and waters. The results of this last examination confirm the correctness of previous conclusions that properly made and cured concrete is suitable for use in all alkali areas except where the sulphate concentrations are abnormally high.

## Changes in Cement Testing

P. H. Bates,[5] chairman of Committee C-1 on Cement, reported a recommendation for the immediate revision of the standard methods of testing cement, and the withdrawal of specifications and tests for the compressive strength of portland cement mortars.

Measurement of particle sizes of portland cement was described in a paper by P. S. Roller.[6] An improved air analyzer is employed to determine the percentage, by weight, falling within certain size limits ranging from 80 microns down to less than 5 microns.

Raymond E. Davis,[7] chairman of Committee C-12 on Mortars for Unit Masonry, reported the organization of this committee and an outline of the work planned.

P. J. Freeman,[8] chairman of Committee D-4 on Road and Paving Materials, presented proposed revisions of the tentative method of test for consistency of portland cement concrete.

Cloyd M. Chapman, consulting engineer, New York City, was elected president of the A. S. T. M. for the coming year.

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[1] Consulting Engineer, New York, N. Y.

[2] Associate Professor of Applied Mechanics, Kansas State College of Agriculture and Applied Science, Manhattan, Kans.

[3] Research Assistant Professor of Engineering Materials, Lehigh University, Bethlehem, Penna.

[4] Dean of Engineering, Iowa State College, Ames, Iowa.

[5] Chief, Silicate Products Division, U. S. Bureau of Standards, Washington, D. C.

[6] Associate Chemist, U. S. Bureau of Mines, Non-Metallic Minerals Experiment Station, New Brunswick, N. J.

[7] Professor of Civil Engineering, University of California, Berkeley, Calif.

[8] Consulting Engineer, Pittsburgh Testing Laboratory, Pittsburgh, Penna.

# Embedded Stone Concrete Produces Low-Cost Walks and Floors

### Arkansas Contractor Develops Local Business—Claims Saving of 20 to 40 Per Cent–Similar Construction for Walls and Arches

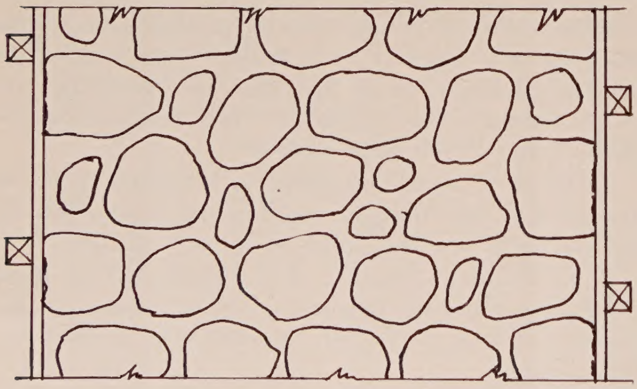
By **JOHN CALHOUN**
**Contractor, Bradford, Ark.**

A PROSPECTIVE builder seems to be more interested in cost than in any other feature, and any economy that can be brought to his attention will often cause him to build. For several years the writer has used a method of construction that has been the means for building numerous concrete walks, floors in stores, garages and porches, where, otherwise, wooden construction would have been used.

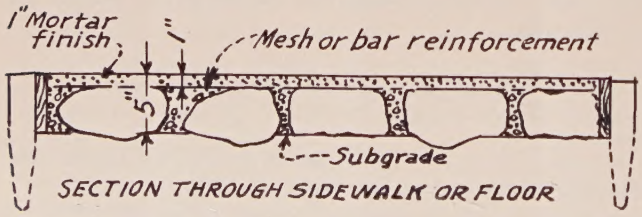
Very often concrete floors have been built cheaper than the replaced wooden construction.

## Use of Embedded Stones

The method involves the use of rock, and of course it can not be employed where rock is not available in plentiful supply. The forms are built and the grade is prepared as for ordinary work. Upon the subgrade stones are laid by hand about 1 in. apart and with their tops about 1 in. below the finished surface. These stones should not be more than 12 to 15 in. in their principal dimension, unless they are very rough and furnish extra good surface for bonding to the concrete. Should a stone be too thick to set 1 in. below the finished grade a hole can be excavated in the subgrade, or it can be broken to size. Laborers become highly skilled in this line after some experience.



STONES IN POSITION FOR PLACING CONCRETE



SECTION THROUGH SIDEWALK OR FLOOR

Stones embedded in concrete produce walks, floors and walls at low cost

## Placing Steel and Top Course

If it is desired to use reinforcement this is placed upon the stones. This leaves it in its exact theoretical position. If the walk is to be built with a topping course, concrete is run over the stones to the concrete grade and is then tamped with a tamping stick slightly less in thickness than the distance between the stones. The topping is then placed after the usual procedure.

## Saves 20 to 40 Per Cent

This method will save from 20 to 40 per cent of the cost of the standard sidewalk. It is not only as good as the standard walk, but better.

## Reduces Contraction of Concrete

The temperature joints may be placed farther apart than with ordinary concrete construction, with safety. The reason for this is evident. Numbers of the cracks in walks are caused by contraction before the concrete has attained sufficient tensile strength to enable it to readjust itself to movement. The stone has received this strength and also does not contract as much as new concrete. In fact, it seems that some stones change very little at ordinary temperatures. To illustrate, should there be 6 lin. in. of concrete and 42 lin. in. of stone in a 4-ft. block or walk, seven-eighths of the contraction would be furnished by the stone, and one-eighth by the concrete. The adhesion between stones and concrete is perfect if ordinary precautions are taken to insure this bond.

## Suited to Many Kinds of Work

It may be thought that stone-concrete is not suitable for use with reinforcement, but that is not the case. The writer has used reinforcement with stone-concrete for years. This use includes arches, walls, pavement, walks and flat beams. The writer believes there is a large field open here for increasing the use of cement and steel, as well as work for the concrete contractor. It is impossible to build as economical a wall of a given strength with any other material.

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## Safety Council Congress

The twenty-first annual congress of the National Safety Council will be held at Washington, D. C., October 3 to 7, W. H. Cameron, secretary, has announced.

# Making, Curing and Testing of Concrete Cylinders

## Concrete for Test Specimens Should Be Taken from Forms—Importance of Curing—Two Sets of Cylinders Supply Separate Information

By D. B. RUSH
Manager, Cement and Concrete Dept., Robert W. Hunt Co., Chicago, Ill.

The final article of this series on testing and inspection of concrete and concrete materials, scheduled to appear in the next issue, will deal with field supervision of concrete work on construction projects.—The Editors.

THE need for some method of checking the strength of the concrete design was felt from the early days of concrete construction. Several methods have been evolved and tried. Taking a core, or sample, from the finished structure is one of these methods; it is still used under extreme circumstances, but because such practice often considerably weakens the structure, other methods have been adopted. Concrete blocks were tried for some time, but cylinders have proved the most practical and are generally used today. The concrete cylinder affords an opportunity to check the correctness of the concrete design and also to ascertain, within certain limits, the strength of the concrete in the structure.

### Accuracy of Cylinder Tests

The accuracy with which the strength of the structural concrete is measured depends, first, on the method of sampling concrete; second, on the character of the mold and the way the concrete is placed in it; third, upon the accuracy and the method of curing cylinders.

It does not make any particular difference as to the age at which cylinders are tested. It is true that the ages of 7 and 28 days have apparently become standard, but good results can be and are had by testing cylinders at 1, 3, 5, 7, 14, 21 and 28 days, 6 months and even up to several years. In fact the real criterion of the strength of concrete structures is not a few days or weeks, but it should be at least several years, the average commercial life of structures being considered as 25 years.

Most certainly the present day architect or engineer does not want to wait 5 years to find out whether the contractor has built a safe and sound building for him. As a result of this the earlier ages of cylinders are used, but they should be used with the understanding that the results obtained are merely an indication of what the ultimate strength of the concrete will be.

Now, relative to making up the cylinders, a sample of the concrete may be taken as it comes from the mixer or from the buggy or wheelbarrow before it is dumped in the forms, or it may be taken from the forms after it has been placed and puddled.

The inspection engineer, with knowledge of his business, will never take concrete for cylinders other than from the forms after it is placed, unless it is absolutely impossible to do it in this way. The outstanding example of this is in the filling of deep foundation caissons where it is obviously necessary to sample the concrete as it is being placed. In this instance, however, whether it be transported in trucks, buggies, chutes or any of the other common methods, the concrete should be dry enough to prevent segregation, and the resulting cylinders are a fair average of the work.

If for any other reason it is necessary to take material from the buggy or conveyance, it is vitally necessary that the concrete be re-mixed before the cylinder is cast.

### Types of Cylinder Molds

Now there are a good many kinds of molds that are recommended and used. The mold recommended by the rather out-of-date A. S. T. M. specifications for the making and curing of concrete cylinders in the field prescribes a metal cylinder open at both ends and split along one side to permit its easy removal from the hardened concrete. Such a mold is satisfactory for use in the laboratory, but the use of either glass or metal plates on the top or bottom is not at all convenient for field work. Unfortunately the bottom and side openings permit the escape of water and cement when concrete is placed quite wet.

Quite a number of concerns manufacture cardboard molds, some with fixed and some with removable bottoms. Some are paraffined and some are not. Essentially, they are made about like a glorified mailing tube. These molds are a great deal cheaper than any others, and as a result are often recommended, but they are far from the best obtainable mold and have a good many features that are quite objectionable.

### Metal Molds Recommended

The price of the mold itself is not as much as the cost of the labor in making up the cylinders, and it has always been our opinion that the mold used should be made of metal, made absolutely to size, true and smooth, and should have an attached metal base, making the mold conform as nearly as consistent with the A. S. T. M. specifications and still have it suitable for handling in the field.

We have had these molds made up special, in three different sizes—that is, 3 by 6 in., 6 by 12 in., and 8 by 16 in. Each mold is only used once, but it gives absolutely accurate results if properly filled and handled. The standard size, of course, is 6 by 12 in.

The smaller size molds we use for roofing gravel, cylinders, gypsum products and other materials of a finer texture. The standard 6 by 12-in. cylinder is used for all ordinary work where the aggregate does not exceed $1\frac{1}{2}$ in. maximum. For aggregate above this size we unqualifiably recommend the 8 by 16-in., or even a larger size mold, because if you attempt to put $2\frac{1}{2}$ or 3-in. aggregate into a 6 by 12-in. mold you do not have enough of the cement matrix surrounding the rock to provide anything like the proper supporting or binding power.

The old idea of taking out the larger sizes of rock and making up a cylinder with the remaining mixture gave results that were entirely misleading.

### Making and Storing Cylinders

In filling these molds the concrete should be placed in 3 to 4-in. layers and each layer puddled with 25 strokes of a $\frac{5}{8}$-in. rod, bullet pointed at the bottom end. From 2 to 4 hours after molding, the specimen should be capped with a thin layer of stiff, neat cement paste on the upper end, and the serial number and identification of the cylinder should be scratched into this soft mixture. The cylinders should then be stored in some location where they will be kept as near as possible at 70 deg. F. and not molested or shaken up for a period of 48 hours.

It is the better practice to make all concrete cylinders in duplicate, one set being kept on the job and cured under exactly the same conditions as the concrete in the structure. In other words, if the concrete in the structure is covered with sand or sawdust, or inclosed in tarpaulins and heated, so should be this first set of cylinders. The second or duplicate set of cylinders should be properly boxed in sawdust and sent direct to the laboratory, where the molds should be stripped and the concrete cylinders placed in a fog room maintained at a temperature of 70 deg. F. and a relative humidity of 95 to 100 per cent.

It is seldom, with the present-day cements, that cylinders can not be moved without fear of injuring them within 48 hours. If for any reason there is any liability of injuring the cylinders they should be kept exactly where originally placed, until such a time when their structure will not be affected by handling.

### Curing Is of Vital Importance

Now as to the third necessary precaution, the curing of cylinders is of vital importance. We have found from long experience that it is not satisfactory to cure cylinders in damp sand. It costs more to cure them in a fog room, and this fog room must be maintained at a uniform temperature; but this is the only known way of curing cylinders so that the proper interpretation can be placed upon their ultimate strength.

If properly made, these cylinders, cured in the laboratory, check the design of the concrete mix as well as the aggregate, and finally, the test of the cement itself.

### Information from Job-Stored Cylinders

The other set of cylinders, properly made and cured under job conditions, both as to temperature and humidity, indicates the strength of the structure under construction. From them can be determined the proper period for the removal of forms, whether or not the curing and protection of the concrete is satisfactory, and a good many other items of valuable information for both the contractor and the designer.

As stated at the start, the date at which these cylinders should be tested is rather immaterial, so long as the duplicate sets are tested at the same age—and this for comparative purposes.

### Inspecting Engineer Should Make Cylinders

In some instances architects and engineers specify that the cylinders shall be made up by the contractor and then submitted to the laboratory for test. This practice may save a little money, but the amount of money saved is so small, in comparison with the concrete sub-contract itself, that it is often amusing.

The cost of the cylinders so made up, submitted and tested is so little in comparison with the information and value that may be derived from them where the inspecting engineer makes up and takes care of the cylinders, that the small additional cost is repaid many times to the owner, architect and contractor alike.

Many times opinions or judgment, involving a considerable amount of money, are based on results of tests that are more misleading than they are instructive, simply because they can be obtained for a few cents less per cylinder than it would have cost to do the work properly.

## ~ PERSONALS ~

*Anson Marston,* dean of engineering at Iowa State College, Ames, Iowa, has retired from his administrative duties as dean of the department, effective June 30. While he will continue in charge of some courses, he expects to spend the greater part of his time in research work.

*Thomas R. Agg,* now assistant dean, will succeed Dean Marston.

*E. B. Bushnell* has been appointed eastern sales manager of the Masonite Corporation. Offices are located at 551 Fifth Avenue, New York City.

*T. D. Gaskin* succeeds Mr. Bushnell in charge of the concrete forms division for the Indiana and Michigan district. His headquarters are at Chicago.

Prior to joining the Masonite Corp. several years ago Mr. Bushnell was connected with the Cement Products Bureau of the Portland Cement Association, where his special work consisted of a study of low-cost concrete house construction.

*P. J. Freeman,* chief engineer of the Bureau of Tests and Specifications of Allegheny County, Penna., has rejoined the staff of the Pittsburgh Testing Laboratory, Pittsburgh, Penna. Mr. Freeman formerly was connected with the latter organization.

*W. F. Lockhardt,* secretary-director of the National Terra Cotta Society, and formerly with the New York office of the Portland Cement Association, has been appointed manager of the technical department of the Keystone Portland Cement Co., Philadelphia, Penna.

# EDITORIAL

## More Sources of Light-Weight Aggregate

ONE difficulty that the concrete products industry as a whole has encountered in the manufacture and marketing of light-weight building units arises from the fact that light-weight aggregates are not everywhere available on short hauls.

The result is that many products manufacturers can not obtain light-weight aggregates at all, while others are working under severe handicaps because freight charges add a big item to the unit cost.

Gradually this situation is being corrected, through the establishment of new plants in sections not now served by near-by plants.

For illustration, a plant in California recently started commercial production of a burned clay aggregate after several years of experimentation. Several other similar products are under development in that section.

In St. Louis, a plant producing a processed slag aggregate was opened early this year, and a new plant in Tennessee is expected soon to start commercial production of a slag aggregate under a different process.

In Pennsylvania a new process for producing a burned clay aggregate is under development; and added to all these are the existing plants now producing processed slag in Chicago and burned clay aggregate in seven cities stretching from Kansas City to Toronto. Then, too, there are the various industrial centers where suitable cinders are available.

The products industry may in time be able to obtain light-weight aggregates at a reasonable price in all sections of the country. In that event the sale of light-weight units will be greatly facilitated.

## Not Overlooking High Early Strength

HIGH-EARLY-STRENGTH cement will be an important factor in the next revival of building construction. Its use in reinforced concrete buildings will be a far more frequent occurrence than it has been heretofore.

This prediction can be made with assurance, for the reason that leading manufacturers of high-early-strength cement are utilizing the present period to bring to the attention of architects and engineers the inherent advantages of this type of cement.

Users of cement are being convinced that the greater cost of high-early-strength cement is often more than offset by cost reductions in other directions.

Twenty-four to 48-hour form stripping schedules are pointed to as requiring much less than the usual amount of form material. This reduces form labor and material costs, because of the smaller number of form sets needed. Earlier form removal also means more re-uses for the form material, and therefore a further reduction in material costs. The use of high-early-strength cement obviates the need for re-shoring, except during cold weather or where floor designs are of an unusually light section.

Protection against cold weather is required for a shorter period, which means a saving in fuel, labor and canvas or other covering. The problem of curing usually ends with the removal of forms.

Above all, early form removal permits greater speed in the erection of the structural frame of a reinforced concrete building. This, in turn, reduces the time required to complete the building, resulting in a corresponding saving in unit costs on overhead items such as salaries, rents, equipment charges, and miscellaneous operating expenses.

Actual savings percentages will doubtless be found to vary with individual contracts; but certain sources of cost reduction are fundamental with the use of high-early-strength cement. Progressive architects, engineers and contractors will not continue to overlook these advantages.

## Without Glutting an Over-Supplied Market

"HIGHWAYS are about the only thing that can be produced without glutting a market," is a statement credited to Frederic E. Everett, president of the American Association of State Highway Officials and commissioner and state engineer of the New Hampshire highway department.

In editorials in previous issues "Concrete" has pointed out the widespread distribution of employment involved in highway construction, and the manner in which the materials utilized in highway construction represent much additional labor in their production, shipment and delivery. Highway construction reaches far back into other industries to confer its benefits, and the money paid out for highway labor is soon translated into the purchase of necessities.

With road costs reduced by a fourth or more, with thousands of men in every state in need of employment, and with an actual need for the facilities which these men can build, our national, state, county and city governments have a duty to perform.

As Mr. Everett has said, this army of road builders will produce something that is needed, something that can be put to immediate use without glutting an oversupplied market.

# PROGRESS—In a Page

**Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups.**

## Standard Colors and Finishes for Cast Stone

A PROPOSED commercial standard for colors and finishes for cast stone has been submitted by the Cast Stone Institute for consideration before the Division of Trade Standards of the U. S. Department of Commerce, Washington, D. C. A preliminary conference of interested manufacturers was held on June 17 in Washington.

The proposed standard in its present form covers those colors and finishes which constitute a large proportion of the production of the cast stone industry. It is expected that, as the demand arises, the standard will be extended to include other colors and finishes.

The proposed standard submitted by the Cast Stone Institute contains an appendix in which recommended working specifications for cast stone are given.

A cast stone exhibit on display from June 15 to 17 served as an additional attraction to those who attended the conference.

## Standardization Proposed for Coarse Aggregates

SOME months ago representatives of the Crushed Stone Association, the National Sand and Gravel Association and the National Slag Association reached a tentative agreement on a classification of size gradations for coarse aggregate in concrete work and other commercial uses of these materials.

It is now expected that producers and consumers will be brought together by the division of simplified practice, Bureau of Standards, Department of Commerce, to discuss the formulation of standard sizes that will be mutually satisfactory. The proposals of the technologists of the three national mineral aggregate associations may well serve as a basis for discussions preliminary to such a conference.

## Approve Standard Engineering Symbols

SYMBOLS for use in mechanics, in structural engineering and in materials have been approved by the American Standards Association, 29 West 39th Street, New York City.

Teachers, technical writers and publishers of technical literature will welcome standardization in this direction, something which has long been needed.

## Concrete in Sea Water

COPIES of the twelfth annual report on the deterioration of concrete in sea water, issued by the British Institution of Civil Engineers, can be obtained by addressing that society at Great George Street, Westminster, S.W.1, London, England.

The committee that issued this report has been investigating the effect of sea water on concrete since 1916, the first of the committee's findings having been issued in 1920. The present report consists mainly of results observed on structures or test specimens exposed to sea water for a considerable period of years. Some specimens have been subjected to the action of artificially prepared sea water having three times the normal strength.

## Highway Research Board to Publish Rail-Steel Bar Report

The eleventh *Proceedings* of the Highway Research Board, 2101 Constitution Ave., Washington, D. C., will be made available for distribution the latter part of July.

This year the *Proceedings* are published in two volumes, designated as Part I and Part II. The former contains the general reports, while the latter is the final report on the results of the investigation of the use of rail steel reinforcing bars in highway construction.

The price for both volumes is $2.00, on orders placed at or before the time of publication.

## Bridge and Structural Engineering Publications Available

THE International Association for Bridge and Structural Engineering, with headquarters offices at the Swiss Federal Institute of Technology, Zurich, Switzerland, has issued two volumes, one of which contains the preliminary report of the Paris Congress of 1932. The other volume constitutes this association's *Publications* (Volume 1).

The price of each of these volumes is set at 25 Swiss francs to members and 35 Swiss francs to non-members of the association.

## To Standardize Testing Sieves

WORK on the establishment of national standard specifications on sieves for testing purposes is now under way in the technical committee recently organized under the auspices of the American Standards Association, 29 West 39th Street, New York City. The National Bureau of Standards and the American Society for Testing Materials are jointly directing the technical work of the committee.

## A. S. A. Specifications for Fine Aggregate

THE American Standards Association, 29 West 39th Street, New York, has published a standard specification for fine aggregate for portland cement concrete pavement or pavement base. The new standard is designated by the symbol SS-F-351.

Copies may be bought by addressing this organization.

# High-Pressure Steam Accelerates Rate of Hardening

## Greater Strength Also Attained—Lehigh Portland Cement Co. Investigators Report Tests—Some Aggregates Believed Unsuitable—Further Investigation Needed

SOME 20 years ago the U. S. Bureau of Standards reported the results of an investigation[1] showing that mortar and concrete cured in steam at 80 lb. pressure attained a compressive strength in two days which was higher than that attained in 28 days to 6 months of normal curing; that the strength and rate of hardening increased with increase in pressure and time of exposure to steam, and that concrete so cured was lighter in color and more uniform in appearance than concrete cured at ordinary temperatures. In view of these promising indications it is difficult to account for the fact that in all these years so little interest has been displayed in the commercial possibilities of high-pressure steam curing of concrete products. We are aware that one department of a large corporation had the vision to see these possibilities, and has profitably employed high-pressure steam curing in the manufacture of a special concrete product for more than 15 years. Subsequently there seems to have been little or no further systematic study of the subject, and nothing attracted much attention until Woodworth's report in 1930 of tests on the steam curing of concrete blocks at a commercial plant in Dayton, Ohio.[2]

### Scope of Investigation

About a year ago the authors began preparations for experimental work in this field, and bearing in mind the practical aspects of high-pressure curing, it seemed that a more complete exploration of the effects of time and pressure, particularly in the region above 80 p.s.i., should be first undertaken. Accordingly the main objective in the preliminary studies reported herewith was to determine the effects of pressure and period of steaming over what might be considered the practicable range in plant operation.

### Outline of Program

The original selection of pressures was 75, 100, 125, and 150 p.s.i., and of exposures 18, 30, 42 and 66 hours. The latter were selected mainly for convenience and required no attention outside of regular laboratory hours except for the 30-hour period.

The autoclave used in this investigation was built in our machine shop from second-hand materials. The body of the tank is an old steam header, 15 in. inside diameter and 48 in. long, having heavy flanges on both ends, and fitted with steel cover and welded bottom. There is a thermometer well in the wall of the autoclave about 8 in. above the bottom. Heat is supplied by six 550-watt electric flat iron units held in place against the bottom. Each unit has its own leads, switch and fuse and can be operated independently of the others. One of the units is controlled by a mercoid switch operated by the autoclave pressure which can be set quickly at any point between 50 and 200 lb. pressure. The operation of this automatic switch has been very satisfactory, controlling the pressure within about 1 p.s.i. at any given pressure setting.

In operation the autoclave contains water to a depth of about 5 in. and the specimens rest on a carrier supported above the water, so that they are wholly exposed to saturated steam. After closing the autoclave and placing an insulated hood over the cover the system is slowly heated with all units operating. Approximately 2 hours are required to remove the air from the autoclave. This is accomplished by allowing air and steam to escape through a valve and pipe dipping into a graduate filled with water. The valve is then closed and about 4 hours are allowed for bringing the autoclave and its contents up to the desired temperature. At the end of the curing period the heating units are shut off and the pressure is released at such a rate that atmospheric pressure is reached at the end of 1 hour. The autoclave is then opened and the specimens removed.

### Materials

Delaware river sand and gravel were used almost entirely throughout the series. Two types of marble aggregate used in a small number of specimens gave peculiar results, and will be referred to later.

### Discussion of Results

The results of this preliminary investigation have in general confirmed the results of previous studies in showing that a remarkable increase in strength and acceleration in the rate of hardening of concrete can be obtained by high-pressure steam curing. The results indicate that similar strengths can be developed by curing at a high pressure for a short time, or at a lower pressure for a longer time, but they suggest some advantages other than saving of time in curing at pressures above 100 p.s.i.

There is nothing in these tests to indicate that consistency is an important factor in concrete to be steam cured.

No extended studies of aggregates have been made, but single samples of high calcium and dolomitic marbles

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Condensed from paper presented at 28th annual meeting of the American Concrete Institute, March 1-4, 1932, by J. C. Pearson, Director of Research, Lehigh Portland Cement Co., and E. M. Brickett, Engineer of Tests, Lehigh Portland Cement Co., and published in the *Journal* of the A. C. I., April, 1932.

[1] The Effect of High-Pressure Steam on the Crushing Strength of Portland Cement Mortar and Concrete, by R. J. Wig; Technologic Paper No. 5, Bureau of Standards, Sept. 5, 1911.

[2] Some Tests of Concrete Masonry Units Cured with High-Pressure Steam, by P. M. Woodworth; *A. C. I. Journal*, Feb. 1930 *Proceedings*, Vol. 26, pp. 504-512.

were found to expand appreciably in high-pressure steam, to such an extent that they may prove to be unsuited for concrete to be cured in this manner. This peculiarity may be common to limestones, and possibly to other calcareous aggregates. Our experience with these materials suggests that aggregates, as well as cements, need special tests beyond the requirements of existing specifications, before they can be assumed to be satisfactory for concrete to be cured in high-pressure steam.

Notwithstanding the extra precautions that may be necessary in producing steam-cured concrete, there seem to be excellent possibilities in the process that should be attractive to manufacturers of concrete products. While there is much more to be done in the laboratory, enough information is available on which to base plant experiments, and these will have to be made in any event, before it can be assumed safely that a given product will be the better for high-pressure steam curing. Some of the possible advantages from this method of curing are as follows:

1. Higher quality products, in strength, uniformly lighter color, and stability in regard to volume changes, with elimination or minimization of resultant defects such as crazing and cracking.
2. Completely cured products in 48 hours or less, after making, eliminating necessity for large stocks and storage space, and permitting prompt shipments on special orders.
3. Control of such properties as porosity and nailability, which are practically impossible of control under the usual processing.
4. Economy in cement.

The chief disadvantages are as follows:

1. Considerable investment in high-pressure equipment.
2. Somewhat higher cost of curing.
3. Some restrictions in the use of materials ordinarily considered satisfactory for concrete.

Some of the factors which need further investigation are the following:

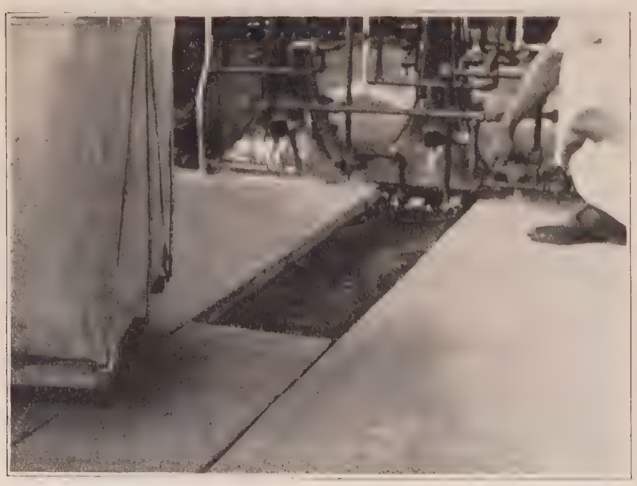
1. The effect of soundness of cements in relation to the conditions under which they may be used in steam-cured products.
2. Data on the practical limits for space- or water-cement ratios.
3. The behavior of various types of aggregate in high-pressure steam.
4. The effect of rate of heating in relation to the size of steam-cured specimens.
5. The effect of period and pressure of steaming, particularly at periods less than 12 hours.
6. The effect of age before steaming, particularly of ages less than 24 hours.
7. Determination of the degree of stabilization of volume changes in the cured concrete, particularly with reference to shrinkage and the fluctuations of expansion and contraction with temperature and humidity change.
8. Assurance that the remarkable acceleration in strength and hardness of high pressure steam-cured products has no undesirable after-effects in relation to strength, stability and durability.

* * *

# Provide Access to Pipe Trenches in Concrete Floor of Laundry

By C. W. GEIGER

The Ideal Laundry in San Francisco is a one-floor, daylight plant housed in a reinforced concrete building 100 by 275 ft. in size. There are 6-in. reinforced concrete curtain walls with reinforced concrete pilasters of unusual strength to support the 100 ft. truss span, which consists of steel trusses made of "H" and "I" sections. The main laundry work room has a clear floor area of practically 100 by 200 ft. in dimensions.



**Removable reinforced concrete slabs over drains and pipe trenches provide continuous trucking surface and access to trenches**

The washers stand on concrete slabs 12 in. thick. All of the steam and water lines from the power plant to the wash units and the soap, bleach and soda pipes as well, are carried in concrete floor trenches varying from 9 in. wide by 6 in. deep to 2 ft. wide by 15 in. deep. The laundry is entirely free from overhead lines. To give a smooth unbroken trucking floor, combined with ease of access to the pipe-lines, the covers of the trenches consist of removable reinforced concrete slabs from 2 to 3 in. thick, as shown in the illustration.

All the conduits for electrical wiring are laid in the concrete floor slab and brought up to the proper motor connections on the machines.

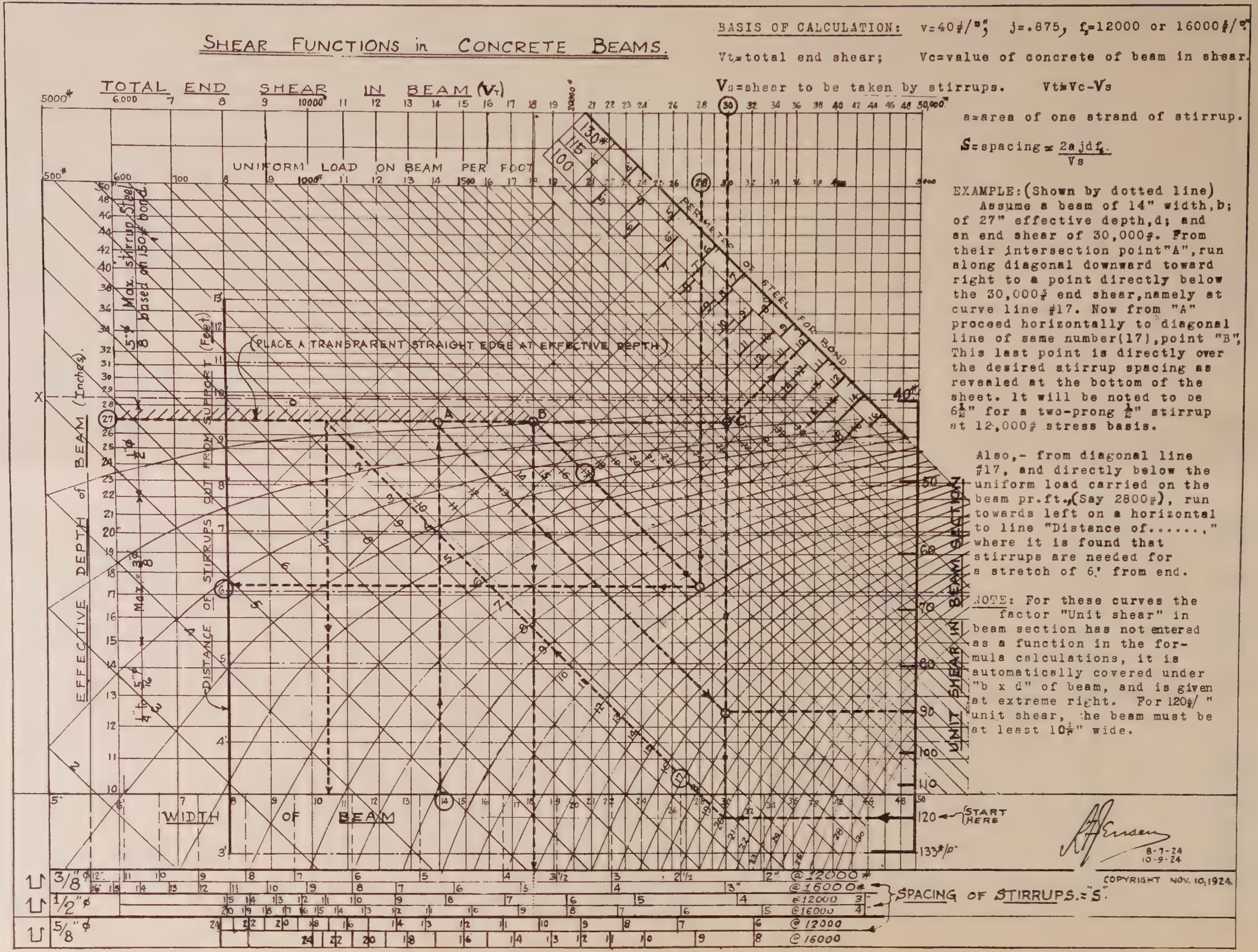
# Chart Determines Shear Functions in Concrete Beams

The Jensen chart for the determination of shear functions in reinforced concrete beams, shown on the opposite page, is an unusually complete "short-cut" for structural designers.

From this chart the designer may determine the required beam dimensions for a given end shear, or the unit end shear where the dimensions are given. He may also obtain the spacing for U-stirrups of 3/8-in., 1/2-in. or 5/8-in. round bars, the distance from the support within which stirrups are required, and other necessary information. The best way to become familiar with the chart is to use it, aided at the beginning by the example given at the right.

R. F. Jensen, of Chicago, constructed this design chart in 1924, and had it copyrighted. It has not been published previously in any technical journal.

# Jensen Chart Determines Shear Functions of Concrete Beams



BASIS OF CALCULATION: v=40#/□"; j=.875, $f_s$=12000 or 16000#/□"

Vt=total end shear; Vc=value of concrete of beam in shear.

Vs=shear to be taken by stirrups. Vt=Vc-Vs

a=area of one strand of stirrup.

$$S = \text{spacing} = \frac{2ajdf_s}{Vs}$$

EXAMPLE: (Shown by dotted line)

Assume a beam of 14" width, b; of 27" effective depth, d; and an end shear of 30,000#. From their intersection point "A", run along diagonal downward toward right to a point directly below the 30,000# end shear, namely at curve line #17. Now from "A" proceed horizontally to diagonal line of same number (17), point "B". This last point is directly over the desired stirrup spacing as revealed at the bottom of the sheet. It will be noted to be 6½" for a two-prong ½" stirrup at 12,000# stress basis.

Also,- from diagonal line #17, and directly below the uniform load carried on the beam pr. ft., (Say 2800#), run towards left on a horizontal to line "Distance of......," where it is found that stirrups are needed for a stretch of 6' from end.

NOTE: For these curves the factor "Unit shear" in beam section has not entered as a function in the formula calculations, it is automatically covered under "b x d" of beam, and is given at extreme right. For 120#/□" unit shear, the beam must be at least 10½" wide.

AJensen
8-7-24
10-9-24

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# HOW TO DO IT

**✦ Questions and Answers ✦**
**Consultation and Comment**

*A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.*

## How Sugar May Cause Trouble with Concrete

*The wholly unexpected ways in which sugar may come into contact with newly placed concrete, and prevent the concrete from hardening, is told in the following letter from J.-Ign. Bilodeau, president of Bilodeau Ltee, a Quebec firm of contractors who specialize in concrete work. The instances which he describes are of the kind that any contractor is likely to encounter. He writes:*

I was much surprised the other day when I read in a certain trade publication that mortar was benefitted by the addition of sugar, because my experience has been quite the contrary. Then I read in the June issue of CONCRETE that sugar was beneficial to lime mortar, but harmful to cement mortar.

My experience was on a contract for sidewalk work in a village about 10 miles from Quebec. My foreman bought a 60-gallon barrel which formerly contained cane syrup, rinsed it out, then filled it with water to be used in the mixing of concrete. Bad weather delayed the start of concreting until the next day, when this water was used. The following day I went to the job, and found that the concrete placed the day before had not set. One of the laborers reported that for some reason he had tasted the water in the barrel and it had a sweet taste. Not knowing that sugar would be harmful to concrete, he had said nothing about it. We then rinsed the barrel thoroughly with hot water and had no more trouble.

Another contractor in this city had an unusual experience, about 15 years ago. He was enlarging a candy factory, the new addition having been built in a part of the yard where empty sugar and syrup barrels had been stored for years. Apparently the ground was soaked with syrup. They dug holes for the concrete footings for columns, and placed the footing forms. Before the concrete was placed it rained, after which the concreting and backfilling were completed, the forms having been left in place. When the steel columns were set the concrete footings gave way. It was found that the concrete had not hardened at all. It was removed with shovels, tight forms were built in place of the old forms, and all water was pumped from the holes before the new concrete was placed. This time the concrete hardened in the usual way.

## Concrete Tennis Court Standards

*We are preparing to cover an old clay tennis court with concrete. Where can I get detailed information on what is considered standard practice as well as standard dimensions in tennis court design and construction?—B. H. W., Cincinnati, Ohio.*

You will find complete specifications for concrete tennis courts, and detailed drawings showing plans and cross-sections, on pages 51-53 of the July (1930) issue of CONCRETE.

Likewise, in the May (1932) issue of CONCRETE, pages 23-24, an article headed "Market for Concrete Tennis Courts," contains a number of important points which should be at hand when laying out such courts.

## Repair of Small Cracks in Concrete Tanks

*The following method of repairing small cracks in concrete floors or concrete tanks has been sent in by Frank E. Gardner, of Gardner Laboratories, Inc., Chicago, Ill. In his letter the writer has reference to the item headed "Repairing Cracks in Concrete Water Tanks," printed on page 33 of the May (1932) issue of* CONCRETE. *Mr. Gardner writes—*

I was extremely interested in the question by R. E. B., of Wheeling, W. Va., and your reply as given on page 33 of the May issue of CONCRETE.

The information that you have given him is excellent and will undoubtedly stop leakage through the cracks permanently. We have had problems of this sort presented to us many times and have found that the owner had been perfectly satisfied when the method you describe is followed.

There have been cases, however, when the crack was small and the expense of such a method did not seem justified. For such cases we have developed a material that is quickly applied and does not interfere for more than a few hours with the use of the tank. This material was first developed as a means of stopping leakage through construction joints and fine cracks in the upper floors and roofs of storage garages. In such cases the material is applied to the ceiling after thoroughly cleaning it with a wire brush, the cleaned strip extending 3 or 4 in. on each side of the crack. The closing of small cracks in tanks is accomplished in a similar manner.

## Comparative Costs of Types of Construction

*Where can I get reliable cost comparisons between types of building construction such as structural frames of reinforced concrete and fabricated steel, and between these structural frame types and bearing-wall construction?—M. A. R., Ithaca, N. Y.*

Information on cost comparisons between types of building construction can be obtained from the Portland Cement Association and the Concrete Reinforcing Steel Institute. Reliable information will also be found in recently published books on estimating building costs, a brief list of which is being sent to you.

# New Books and Pamphlets

## Engineering Details of Cascade Tunnel

THE EIGHT-MILE CASCADE TUNNEL, GREAT NORTHERN RAILWAY. Published by Carey, Baxter & Kennedy, contractors and engineers, 307 West 49th Street, New York. Cloth, 84 pages, 6 by 9 in., with many halftone and line illustrations.

This book is a cloth-bound reprint from the Proceedings of the American Society of Civil Engineers. The first 9 pages contain a description of the preliminary studies, by D. J. Kerr, assistant to vice-president, operating department, G. N. Ry. A second section of 24 pages is devoted to surveys, construction methods, and a comparison of routes, by Frederick Mears, assistant chief engineer, G. N. Ry. The remaining 51 pages cover a detailed description of construction plans and methods, by J. C. Baxter, of Carey, Baxter & Kennedy, contractors and engineers, New York.

Because of the excellent descriptions and the many detailed drawings and halftone views, this book will be of genuine service to engineers confronted with design and construction problems of this character.

## Survey of Athletic Stadia in Schools and Universities

MUNICIPAL, SCHOOL AND UNIVERSITY STADIA, by Randolph O. Huus and Dorothy I. Cline. Published by the Municipal Administration Service, 261 Broadway, New York, 1931. Paper cover, 33 pages, 6½ by 10 in. Price 35 cents.

This bulletin contains valuable information for the designer who is charged with the layout and the structural design of an athletic stadium. Aside from the data on types of construction, seating capacity, land areas occupied, financing plans, stadium activities within the structure, and cost data, specific information is supplied on details such as height of risers and width of steps, seats, seating capacities, visibility factors, sight obstructions, curved or bowed sides, uses of the interior of the structure, drainage, lighting, handling of crowds, and provision for parking facilities.

## Blast-Furnace Slag as Aggregate

BLAST-FURNACE SLAG AS CONCRETE AGGREGATE. Reprinted from the *Proceedings* of the American Concrete Institute by the National Slag Association, Leader Building, Cleveland, Ohio. Paper cover, 45 pages, 6 by 9 in.

Originally published as a report of Committee 201 of the American Concrete Institute, this pamphlet takes up in detail the results of first-hand investigations of the properties and uses of blast-furnace slag, as revealed in actual performance under service conditions and in the study of test data and technical literature.

A bibliography of technical literature on the use of slag as concrete aggregate is given.

## Tennis Court Booklet

TENNIS COURTS FOR ALL-YEAR SPORT is published by the Portland Cement Association in a revised edition.

This is a 20-page booklet telling at some length of the game, the widespread use of concrete courts, and lastly, directions for their construction.

# ORGANIZATIONS

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS; W. C. Markham, Executive Secretary, 1222-24 National Press Building, Washington, D. C.

AMERICAN CONCRETE INSTITUTE; Harvey Whipple, Secretary, 641 New Center Building, Detroit, Mich.

AMERICAN CONCRETE PIPE ASSOCIATION; M. W. Loving, Secretary, 33 West Grand Ave., Chicago.

AMERICAN ROAD BUILDERS' ASSOCIATION; Chas. Upham, Engineer-Director, National Press Building, Washington, D. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS; Geo. T. Seabury, Secretary, 33 West Thirty-ninth St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS; C. L. Warwick, Secretary-Treasurer, 1315 Spruce St., Philadelphia, Pa.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA; E. J. Harding, Managing Director, 222 Munsey Bldg., Washington, D. C.

BUILDING OFFICIALS CONFERENCE OF AMERICA; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

CAST STONE INSTITUTE; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

CEMENT INSTITUTE; Luther G. McConnell, General Manager, 11 East 44th St., New York City.

CONCRETE MASONRY ASSOCIATION; Jack Franklin, Secretary, 7071 Plankinton Bldg., Milwaukee, Wis.

CONCRETE REINFORCING STEEL INSTITUTE; M. A. Beeman, Secretary, 333 North Michigan Ave., Chicago.

ENGINEERING INSTITUTE OF CANADA; 2050 Mansfield St., Montreal, Quebec.

JOINT COMMITTEE ON STANDARD SPECIFICATIONS FOR CONCRETE AND REINFORCED CONCRETE; F. R. McMillan, Secretary, 33 West Grand Ave., Chicago.

NATIONAL BOARD OF FIRE UNDERWRITERS; W. E. Mallalieu, General Manager, 85 John St., New York City.

NATIONAL CONCRETE BURIAL VAULT ASSOCIATION; J. H. Stuart, Secretary-Treasurer, Bremen, Ohio.

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NATIONAL FIRE PROTECTION ASSOCIATION; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

NATIONAL LIME ASSOCIATION; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

NATIONAL READY-MIXED CONCRETE ASSOCIATION; V. P. Ahearn, Secretary, 545 Munsey Building, Washington, D. C.

NATIONAL SAND AND GRAVEL ASSOCIATION; V. P. Ahearn, Executive Secretary, 545 Munsey Bldg., Washington, D. C.

NATIONAL SLAG ASSOCIATION; H. J. Love, Secretary-Treasurer, 937 Leader Bldg., Cleveland, Ohio.

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NORTHWEST CONCRETE PRODUCTS ASSOCIATION; W. P. Hews, Secretary-Treasurer, Yakima, Wash.

PORTLAND CEMENT ASSOCIATION; Edward J. Mehren, President; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

RAIL STEEL BAR ASSOCIATION; H. P. Bigler, Engineering Secretary; Builders' Bldg., 228 N. La Salle St., Chicago, Ill.

WIRE REINFORCEMENT INSTITUTE; R. D. Bradbury, Director, National Press Bldg., Washington, D. C.

WISCONSIN CONCRETE PRODUCTS ASSOCIATION; Jack Franklin, Secretary-Treasurer, 425 East Water St., Milwaukee, Wis.

# New Equipment and Materials

## Compacted Concrete Pavements Organization and Process

Compacted Concrete is the name of a development in the building of concrete pavements and also of the organization itself. The executive office of this concern is at 924 Andrus Building, Minneapolis, with additional offices in St. Louis, Omaha and in the West. It describes its processes in a bulletin entitled "Compacted Concrete Pavements" and a leaflet headed "Where Records Are Broken."

The process of compacting concrete by impact is a development in concrete road and street construction which is the natural outcome of the experience of the organization's engineers and personnel during the last 12 or 15 years. It has eliminated from past similar methods the multiplication of detail and has simplified the application, so that progress is expedited although the density of the finished slab is increased. A very smooth riding surface is said to be an added feature.

High strength, high resistance to wear, impervious compacted surface mortar, minimum absorption and uniform density from the top to the bottom of the concrete slab, are some of the inherent qualities claimed for concrete pavements placed by this method.

The new equipment developed by this company delivers blows that constitute a physical force of impact, it is said, the process resulting in the taking out of water and air, and greatly increasing the density of the concrete. The equipment avoids the creation of opposing vibratory waves. It is essentially a compacting process, differing considerably from vibratory methods.

## New 1½-Yard Rex Moto-Mixer Is Introduced

The new Rex 1½-Yard Moto-Mixer (2-yd. agitator) is announced as a new size, but not a new machine. Its design, construction and features are patterned closely after other members of the Rex Moto-Mixer line.

When used as an agitating unit, this new Moto-Mixer fits into the wet plant employing a 2-yd. 56-S plant mixer, handling one batch to a load.

As a 1½-yard truck mixer, this new Rex unit answers the need of small plants for a light, low cost machine that can be mounted upon a small inexpensive truck. Many small plants, particularly those already having bins and batchers, are said to be finding this size profitable on part time work and small yearly concrete volume.

The drum of the standard Moto-Mixer design with conical front section is mounted with three-point suspension.

Mixing water is measured by means of a calibrated overflow pipe, extending into the mixing water compartment. This pipe is set for the desired quantity.

The tank has two compartments, one for mixing water—the other for washout water. Both are equipped with calibrated sight gauges.

The distributing spout is of the Rex One-Man type. It is fastened by two hinges in such a manner that one man can easily swing it from the cradle, in which it rides when the truck is traveling, into discharging position in a very short time.

This new 1½-Yard Moto-Mixer can be had equipped with the Rex-Heil Jackass hoist which the manufacturers claim doubles effective spouting area and permits discharging directly into a 3-yd. storage hopper without using a ramp.

The drum is driven by an independent motor equipped with electric starter which operates from the truck's battery. All controls are located at the rear of the drum.

Complete information on this new Rex Moto-Mixer can be had by writing to the Chain Belt Co., Milwaukee, Wis., asking for Rex Moto-Mixer Bulletin No. 219.

## Improved Fuller-Kinyon Pump Makes Appearance

The Fuller Co., Catasauqua, Pa., announces an improved Fuller-Kinyon pump, Type F, requiring less air pressure and less power, with consequent lower costs per ton conveyed.

The equipment operates on the same principle as the older types, but is simplified mechanically and designed to operate at unusually low air pressures, according to the firm. Pressure ranges from 10 to 20 lb. for average installations.

A number of the mechanical features of the portable pump are incorporated, including a permanently aligned screw shaft bearing assembly. An externally adjustable seal is provided which can be changed by unskilled labor to take advantage of the best operating conditions.

Due to operation at low pressure, wear of working parts is said to be minimized and in addition, parts are protected by specially hard materials to resist abrasion.

## Moist Curing Cabinet Designed to Meet A. S. T. M. Requirements

Automatic control of temperature and humidity for aging cement samples in accordance with A. S. T. M. requirements is said to be provided by the new Aminco cabinet. The unit, developed with the cooperation of several state highway laboratories, provides for storing samples both in moist air and immersed.

The cabinet, ruggedly built of seasoned hard wood, is insulated with 2½ in. of pressed corkboard laid in hot asphalt. The inner liner is of 16-oz. copper, said to be practically corrosion proof. A self-contained sump at the bottom of the cabinet, holding 20 gal. of water, makes the unit independent of water supply. The water is continually circulated by a motor-driven centrifugal pump raising it to a brass pipe header at the back and side walls where it is directed from ⅛-in. copper jets in tiny streams down the copper walls.

Temperature is maintained unfailingly at 70 deg. F. throughout the year through alternate cooling and warming of the sump water, it is claimed.

Descriptive folders are available from the American Instrument Co., Inc., Washington, D. C.

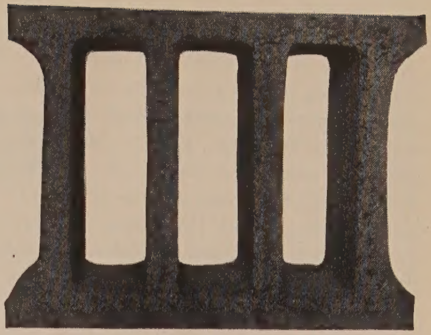
## Performance of Toledo Equipment on Koon Dam Job

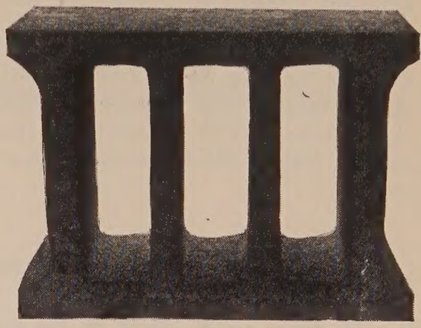
Regarding the use of its specially designed equipment used in the construction of Koon dam in Pennsylvania, the Toledo Scale Co., Toledo, Ohio, states that "the feasibility and efficiency of proportioning concrete by weight has been strikingly proved by the record of the Toledo aggregate determination auto-gage used in the construction of the Koon dam, 720 ft. long and 90 ft. high. When the job, involving approximately 81,000 bbl. of concrete, was completed, the difference between records of materials received and cement used was only 4/10th of 1 per cent including the usual waste in transportation.

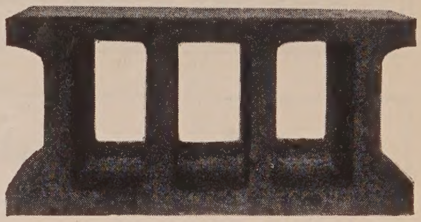
"The electric recording device on the scale gave a complete record (never before obtained on a concrete job) of each batch for future study by engineers. Although the equipment was in operation 24 hours a day, while concrete was being poured and weighed 360,000,000 lb. of concrete, the pivots and other parts of the scale, when inspected at the completion of the job, showed no appreciable signs of wear."

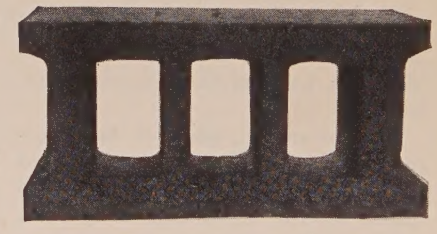
Tuscala. [illegible] 6 City
Tamp'g using 80# [illegible]

# *"Chief, these new light-weight blocks save us 25,000 pounds of mixed concrete every day"*









# *HOW MUCH WOULD YOU SAVE?*

Architects, contractors and owners all like these light weight blocks better. So they boost your sales and cut your costs.

These 8 inch units made from average sand and gravel weigh approximately 38 lbs. and the 12 inch, 55 lbs. Compare that with what your own blocks weigh and then estimate the annual saving you would make by changing. Don't overlook the cheaper handling and hauling costs.

If you have one of the late model Besser Strippers, you can change to this style block very cheaply. If you don't have a Besser Stripper, you are overlooking a labor saving and material saving that would pay for such a machine in a very short time.

The new Besser Strippers can, with inexpensive attachments, make any size and shape of units to meet the rapidly changing demands of the trade. The broad Besser patents permit the use of the same plain wood or steel pallet for making all sizes of units. This is tremendously important.

Tell us what equipment you have and we will quote you on equipment or attachments that will cut your costs and increase your sales.

**BESSER MANUFACTURING COMPANY**

**Branches in Principal Cities** **ALPENA, MICHIGAN**

*This advertiser is showing his readiness to serve you as business improves*

## General Motors Offers New 2- to 3-Ton Truck

Increasing its line to meet the expanding requirements of the trucking field, the General Motors Truck Co., Pontiac, Mich., announces a new 2- to 3-ton truck, powered with a 66-hp. 6-cyl. engine. The new truck, known as the Model T-23, takes its place as the lowest priced commercial vehicle in that range it has ever offered, the firm states.

Featuring a full-floating rear axle and main and auxiliary rear springs, the new truck is offered with ten different body types covering a wide field of use.

Straight rating of Model T-23 is 10,000 lb. and when used as a tractor with the recently announced TT-218 semi-trailer, the payload capacity can be practically doubled.

The powerful 6-cyl. engine, developing 66 hp., has a counter-balanced crankshaft equipped with an harmonic balancer to eliminate destructive engine vibration at any speed. Full-pressure lubrication is provided, including rifle-drilled connecting rods. Through a heavy-duty transmission, with four speeds forward, tubular propellor shafts and a rugged full floating rear axle, the power of this sturdy engine is transformed into profitable truck work.

The long semi-elliptic springs are correctly proportioned to provide proper carrying capacity with easy riding. The front springs are fitted with snubber leaves and self-adjusting shackles. The rear springs are of the two-stage type (main and auxiliary) providing easy riding under light loads and proper stiffness under full loads, at the same time counteracting sidesway.

## Nailable Cinder Block Approved by Underwriters

The Underwriters' Laboratories recently approved Nailcrete nailable cinder block and as a result "Certificated" block for walls or partitions can now be furnished by Nailcrete licensees where this type is specified, according to the Nailcrete Corp., New York City.

Nailcrete nailing concrete was first developed 16 years ago as a fire resisting material and was followed by Nailcrete nailable cinder block using asbestos.

Nailcrete block can be made wherever suitable cinders are available in commercial quantities. Features of the process are the steam treating, elimination of furring on exterior walls when used as backup, and acoustic properties lessening sound transmission.

# About Makers of Equipment and Materials

## Industrial Literature

### *Artistic Concrete*

*Artistic Concrete* is the name of a new monthly publication issued by the *Cement Marketing Company, Ltd.*, London, England.

The first number, issued in April, contains 16 pages, 7 by 10 in., with 12 colored illustrations showing the use of colored cement concrete in buildings, bridges, sea walls, sea-front promenades, swimming pools, and flagstone walks.

### *Proving Machines Folders*

*The Morehouse Machine Co.*, York, Pa., is distributing a new 6-page leaflet on proving instruments for checking materials testing machines.

Units of several different capacities are shown, some in actual use.

### *Fuller Cement Batchers*

Full automatic and manual weighing type cement batchers are described in a 4-page folder prepared by the *Fuller Co.*, Catasauqua, Pa.

The design is based upon a flood-proof measuring feeder, known as the Fuller rotary feeder, which is said not to flood even when withdrawing aerated cement. Both types are built to 1932 New York state highway specifications.

Some of their features listed are accuracy and speed, discharge gate interlocked against over and under weights, remote push-button control, large inlet for free bin discharge, and controlled batch discharge.

### *Recorder Leaflet*

*The Southwark-Emery stress-strain recorder* is described in a 4-page leaflet being distributed by the *Baldwin-Southwark Corp.*, Philadelphia, Pa.

The recorder is said to construct, at normal testing speed, a stress-strain graph which is the equal of the most painstaking point-by-point graph and consistently far superior to the average graph of that type.

### *Savings with High-Early-Strength Cement*

The May issue of *"Incor" News* carries two interesting articles, one telling of the saving on a highway bridge in Alabama, through the use of high-early-strength cement, and the other telling of the elimination of a long detour on highway construction in Virginia, by careful planning of the work and the use of special cement.

"Incor" News is published by the makers of Incor and Lone Star cements.

## Manufacturers News

### *Flint Rock Aggregate*

*The Neff and Fry Co.*, Camden, Ohio, has been appointed the distributor for facing materials produced by the *Flint Rock Co.*, Ingomar, Ohio.

The latter formerly also distributed the materials, but demand has necessitated that all efforts be devoted to manufacturing.

The Flint Rock Co. produces granite and quartz aggregates, and furnishes building stone for homes, fireplaces, rock gardens and similar uses.

### *Products Equipment Distributors*

*The Concrete Machinery Corp.*, Newark, N. J., has been appointed exclusive distributor for the *Besser*, *Anchor* and *Consolidated* lines of concrete products plant equipment. It has also taken over the concrete products division of the *E. B. Kelley Co., Inc.*, of Newark and New York.

*C. S. De Lamater*, for a number of years affiliated with the Anchor and Consolidated companies, and later with the Besser Mfg. Co., is manager.

### *Chain Belt Representatives*

*The Chain Belt Co.* has recently appointed two new distributors in the Florida territory to handle its complete line. These are the *McDonald Tractor Co.*, Orlando, Fla., and the *Burgman Tractor Equipment Co.*, 8 Riverside Viaduct, Jacksonville, Fla.